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[Title of Invention] A cold-setting ceramic composition

[Summary]

[Purpose] To offer a cold-setting ceramic composition that is outstanding in resistance to heat and weather, can be applied to the surfaces of concrete and steel structures, and can be used as a rustproofing and adhesive material.

[Design] The composition contains 50 to 60 weight % of silicon dioxide, 15 to 25 weight % of aluminum oxide, 10 to 20 weight % of calcium oxide, and 3 to 14 weight % of iron oxide. The composition is combined with potassium silicate (water glass), kneaded, applied to the surface of a concrete structure, and is allowed to set to form a heat-resistant layer over the said concrete surface. The mixture may also be used as an adhesive for concrete structures.

[Claims]

[Item 1] A cold-setting ceramic composition that contains 50 to 60 weight % of silicon dioxide, 15 to 25 weight % of aluminum oxide, 10 to 20 weight % of calcium oxide, and 3 to 14 weight % of iron oxide.

[Item 2] A cold-setting ceramic composition that is defined by Item 1 of the Claims in which silicon dioxide is a powder having a particle diameter measuring 0.1 to 1 μm.

[Item 3] A cold-setting ceramic composition that is composed of 100 weight parts of the composition defined by Items 1 and 2 and 35 to 45 weight parts of silicate.

[Item 4] A cold-setting ceramic composition having silicate of Item 3 that is water glass of sodium silicate, potassium silicate, or lithium silicate or their mixture.

[Item 5] A cold-setting ceramic composition in which 0.1 to 0.8 weight parts of calcium hydroxide is added to the composition defined by Items 3 and 4.

[Item 6] An adhesive that is a composition defined by Items 3 through 5.

[Item 7] A paint that is a composition defined by Items 3 through 5.

[Item 8] A ceramic form in which a fine aggregate has been combined with the composition defined by Items 3 through 5 and which has been hardened.

[Item 9] A ceramic form defined by Item 8 in which quartz sand serves as the fine aggregates.

[Detailed Description of the Invention]

[0001]

[Technical Area of Application] The present invention concerns a cold-setting type ceramic that is used to coat architectural, construction, and other materials, such as concrete, steel structures, steel-reinforced construction, PC steel, wires, PC steel rods, and exterior wall bases of a building.

[0002]

[Conventional Technology] For exterior coating materials of a building, stone pitching, tiles, metallic panels, and ceramic panels have been used. Tiles and ceramic panels are superior in thermal and weather resistance, associated with a satisfactory external appearance, and improve the durability and resistance of buildings to fire. For these reasons, they are popular as decorating materials. However, sintering at temperatures above 1,200°C is needed in the production of these tiles; it is technically difficult to produce large sizes (the size is often limited to 30 cm square); and the production cost is high.

[0003] The present inventor discovered that cold-setting ceramic--a particle mixture composed of particles of silicon dioxide, calcium oxide, iron oxide, titanium oxide, and aluminum oxide, when combined with quartz sand as a fine aggregate and water glass, hardens at ambient without being sintered to form a ceramic. This mixture can be used as an adhesive.

[0004] When high-strength concrete is exposed to high temperatures (as in a fire), concrete separates from its surface and is ejected at high speed (a rupture phenomenon). To prevent this, the concrete surface may be coated with a foamy insulating material. However, foaming of the coating makes it difficult to control the ultimate thickness of the coating film; and the coating is applied to a thickness slightly greater than necessary, which contributes to an increase in cost.

[0005]

[Problems to Be Solved by the Present Invention] The present invention purports to offer a cold-setting ceramic composition that is superior in resistance to heat and weather, can be applied to concrete structures and steel materials, and can be used as a rust-proofing material and an adhesive. When used as a coating for a concrete structure, in particular, it protects concrete that is not very resistant to thermal effects and prevents its rupture when exposed to fire or high temperatures.

[0006]

[Method to Solve the Problem] The cold-setting ceramic composition of the present invention is composed of 50 to 60 weight % of silicon dioxide, 15 to 25 weight % of aluminum oxide (alumina), 10 to 20 weight % of calcium oxide, and 3 to 14 weight % of iron oxide. This composition is combined with potassium silicate (water glass), kneaded, and applied to the surface of a concrete structure. The composition hardens in a short time, forming a thermally resistant layer over the concrete surface. This composition may also be used as an adhesive for concrete structures.

[0007] When potassium silicate (water glass) is mixed with a powder containing silicon dioxide, aluminum oxide, calcium oxide, and iron oxide, silicon dioxide particles dissolve in water glass and break up into even smaller particles. Thus their surface area increases, facilitating a reaction with calcium oxide and readily forming $3CaO\text{-}SiO_2$ crystals. It is believed that this process explains the rapid hardening of the composition. When combined with calcium hydroxide, the reaction with potassium silicate (water glass) facilitates the formation of $3CaO\text{-}SiO_2$ crystals. It is believed that this further hastens the hardening process.

[0008] The ceramic body that is obtained by hardening of the cold-setting ceramic composition of the present invention is associated with high thermal and weather resistance (using a weather meter) and shows no deviations in a weather resistance test lasting for 3,000 hours. Its compression strength is over 100 N/mm^2 and its hardness is rated at 4 to 5 (Mohs' hardness). It meets the requirement for a covering material for the exterior of a building and its performance is equal to that of tiles.

[0009] When fine aggregate is added to the cold-setting ceramic composition of the present invention and molded and hardened at ambient, diverse types of molded products can be readily manufactured. Thus a plate measuring more than 1 m can easily be produced and the product can be used as a curtain wall.

[0010]

[Application of the Present Invention]

Example 1

[Table 1]

Composition	Weight %	Weight (g)
electric furnace slug silicon dioxide (SiO_2) aluminum oxide calcium oxide (CaO) iron oxide	 55.77 20.80 14.90 8.53	400
potassium silicate (water glass)* silicon dioxide (SiO_2) M_2O water	 35.00 17.00 48.00	330
quartz sand (0.05 to 0.10 mm)	—	100
quartz sand (less than 0.6 mm)	—	600
calcium hydroxide	—	1.5

* Molar ratio (SiO_2/M_2O)

[0011] The mixture shown in Table 1 is agitated for 3 minutes at 500 rpm by using a hand mixer. A ϕ5 x 10 cm mold was filled with this mixture for molding. The physical properties of the product on the seventh day are shown in Table 2.

[Table 2]

Test Item	Test Method	Results
specific gravity (20°C)	JIS A1108	1.70 ~ 1.75
compression strength (N/mm^2)	JIS A1108	>100
bending strength (N/mm^2)	JIS A1113	>25
tensile strength (N/mm^2)	JIS A1113	>11
modulus of static elasticity (N/mm^2)	ASTM C7103T	$4x10^4$
hardness (Mohs')	—	4 to 5
heat impact resistance (ΔT,°C)	—	>800 (normal)
water resistance (in water at 20°C, time)	—	>500 (normal)
resistance to hot water (80°C, time)	—	>1000 (normal)
water permeability (Kg/cm^2·time)	—	>1000 (normal)
natural exposure (years)	—	>8 (normal)
weather meter (time)	—	>3000 (normal)
5% sodium hydroxide (time)	—	>1000 (normal)
5% nitric acid (time)	—	>1000 (normal)
salt water spray test (10% saline, time)	—	>5000 (normal)
freezing-melting test (weight reduction)	ASTM C666	500 cycles (normal)
neutralization inhibition	—	normal after enhancement
fireproofing (1,200°C, 3 hours)	—	normal
concrete adhesiveness (N/mm^2)	—	>2.8 (concrete ruptured)
adhesiveness to asbestos slate (N/mm^2)	—	>2 (asbestos slate ruptured)
adhesiveness to waterproofing veneer (N/mm^2)	—	>1.5 (water-proofed veneer ruptured)
adhesiveness to light weight cement blocks (N/mm^2)	—	>0.8 (block ruptured)

Resistance to heat impact: a sample is heated at 1,000 ± 10 (°C) for one hour followed by a sudden drop in temperature (20 ± 3 °C) and examined for the possible development of cracks or other defects.

[0012] Example 2

The materials included in the mixture are listed in Table 3.

[Table 3]

Composition	Weight %	Weight (g)
electric furnace slug		400
silicon dioxide (SiO_2)	55.77	
aluminum oxide	20.80	
calcium oxide (CaO)	14.90	
iron oxide	8.53	
potassium silicate (water glass)*		350
silicon dioxide (SiO_2)	35.00	
M_2O	17.00	
water	48.00	
quartz sand (0.05 to 0.10 mm)	—	100
quartz sand (less than 0.6 mm)	—	600
calcium hydroxide	—	1.5

* Molar ratio (SiO_2/M_2O)

[0013] The mixture shown in Table 3 is agitated for 3 minutes at 500 rpm by using a hand mixer. A ϕ5 x 10 cm mold was filled with this mixture for molding. The physical properties of the product on the seventh day are shown in Table 4.

[Table 4]

Test Item	Test Method	Results
specific gravity (20°C)	JIS A1108	1.80 ~ 1.85
compression strength (N/mm^2)	JIS A1103	>80
bending strength (N/mm^2)	JIS A1113	>20
tensile strength (N/mm^2)	JIS A1113	>8
modulus of static elasticity (N/mm^2)	ASTM C7103T	$3x10^4$
hardness (Mohs')	——	4 ~ 5
heat impact resistance (ΔT,°C)	——	>800 (normal)
water resistance (in water at 20°C, time)	——	>1000 (normal)
resistance to hot water (80°C, time)		——
water permeability (Kg/cm^2·time)	——	——
natural exposure (years)	——	>8 (normal)
weather meter (time)	——	>3000 (normal)
5% sodium hydroxide (time)	——	>1000 (normal)
5% nitric acid (time)	——	>1000 (normal)
salt water spray test (10% saline, time)	——	>5000 (normal)
freezing-melting test (weight reduction)	——	500 cycles (normal)
neutralization inhibition	ASTM C666	——
fireproofing (1,200°C, 3 hours)	——	normal
concrete adhesiveness (N/cm^2)	——	>2 (concrete ruptured)
adhesiveness to asbestos slate (N/cm^2)	——	>1.8 (asbestos slate ruptured)
adhesiveness to waterproofing veneer (N/cm^2)	——	>1.3 (water-proofed veneer ruptured)
adhesiveness to light weight cement blocks (N/cm^2)	——	>0.8 (block ruptured)

Resistance to heat impact: a sample is heated at 1,000 ± 10 (°C) for one hour followed by a sudden drop in temperature (20 ± 3 °C) and examined for the possible development of cracks or other defects.

[0014]

[Effects of the Present Invention] The ceramic body that was obtained by hardening the cold-setting ceramic composition of the present invention is associated with the superb physical properties listed above. By utilizing its high thermal and weather resistance, it can be applied to the surface of a concrete structure to prevent the latter from rupturing. The hardness of the hardened composition ranges from 4 to 5 (Moh's hardness), which makes it suitable for coating the exterior of a building. By applying it to coat steel materials such as steel-reinforced structures, steel rods and steel plates, it can be used as a rust-proofing material.

[0015] By applying this composition to both sides of a steel plate, a panel having a steel core can be prepared. Because it solidifies at ambient, it may be used as an adhesive to attach

concrete parts. Thus this invention is applicable to diverse areas.